2013

Longitudinal Study of an Aquatic Ecosystem [11th-12th grade]

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UNDERSTANDING BY DESIGN

Unit Cover Page

Unit Title: Longitudinal Study of an Aquatic Ecosystem

Grade Level: 11 and 12

Subject/Topic Area(s): AP Environmental Science, Ecology, Aquatic Ecosystems, Laboratory

Designed By: Maxwell V. Fazio

Time Frame: Entire year or one semester, to be conduct alongside normal instruction.

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Brief Summary of Unit (Including curricular context and unit goals):

This unit is designed to be taught in AP environmental science (APES). It is a year-long unit that allows students to conduct an authentic longitudinal study of an aquatic ecosystem. Students are instructed to gather data on a weekly basis and then analyze it for patterns or trends. This will be done in the klong (canal) just outside of the American School of Bangkok. Note that the instructor can adapt this unit to accommodate their local environment.

The entire class will compile data on a variety of variables using a shared online document. Students will learn to analyze the health of an ecosystem quantitatively and the effects of human impact on that ecosystem. Students will also monitor the biodiversity of organisms (including microorganisms) within that ecosystem.

According to the teacher guide on apcentral.collegeboard.com, the lab component of APES provides the instructor with "an opportunity to put their own stamp on the course." For this reason, the focus of this unit is *not* on acquiring specific content knowledge, but instead on the *experience* of conducting a sophisticated ecological investigation and the skills pertaining thereto. There is also an emphasis on drawing conclusions from a large set of data and supporting them with a combination of experimental evidence and background research.

Goals addressed (Taken directly from the course description at apcentral.collegeboard.org):
- Science is a method of learning more about the world.
- Science constantly changes the way we understand the world.
- Natural systems change over time and space.
- Humans alter natural systems.
- Environmental problems have a cultural and social context.
- Understanding the role of cultural, social, and economic factors is vital to the development of solutions

UbD: Longitudinal Study of an Aquatic Ecosystem

Stage 1 – Desired Results

Established Goals (AP standards)

• Science is a method of learning more about the world.
• Science constantly changes the way we understand the world.
• Natural systems change over time and space.
• Humans alter natural systems.
• Environmental problems have a cultural and social context.
• Understanding the role of cultural, social, and economic factors is vital to the development of solutions

Transfer

Students will independently use their learning to…

- Collaborate with peers to build a set of shared information (using technology).
- Use induction to draw conclusions from a set of data.
- Explain/defend conclusions in front of peers using evidence.

Meaning

Understandings

Students will understand that….

- Ecosystems are dynamic. Some changes occur naturally (due to seasonal, or even daily cycles) and others occur as a result of human impact.
- Many characteristics of an ecosystem can be quantitatively measured.
- Many of these quantities are interconnected and have measurable relationships.
- Some of these quantities have healthy ranges.
- The values of these quantities (pH, nitrate concentration, calcium concentration, dissolved oxygen content) are often indicative of particular stresses on an ecosystem—usually caused by human impact.
- Biodiversity of an environment is dependent on surrounding impacts.

Essential Questions

- What changes occur in an ecosystem over a long period of time?
- How do humans impact an ecosystem?
- How can we determine if an ecosystem is "healthy?"
- What are farming alternatives that can prevent the negative effects of water runoff and fertilization?
- What factors determine which taxa of organisms will live in a particular environment?

Acquisition

Knowledge

Students will know…

- Most types of organisms have specific pH ranges in which they can survive. Different organisms have different ranges depending on their natural habitat.
- pH level can be affected by rainfall (acid rain) and many other environmental factors.
- pH is a logarithmic measurement.
- Low dissolved oxygen (DO) content is an indicator of an

Skills

Students will be able to…

- Collect data efficiently using modern technological resources (labquest interface, ion-selective electrodes, pH sensor, temperature probe).
- Use google apps to record and share data over a long period of time.
- Analyze a large data set for patterns and draw conclusions.
- Present valid conclusions using arguments based on

	overabundance of plants and algae in an aquatic ecosystem. • Low DO content is often caused by fertilization and water runoff. • Fish use DO to breathe. If DO is too low, they cannot survive. • DO content is inversely proportional to temperature. • Nitrates are polyatomic ions that are often produced as fertilizers. • Nitrates are also produced by nitrifying bacteria. • High nitrate levels are often caused by fertilization and water runoff. • High nitrate levels are toxic for most species of fish. • Calcium concentration in an aquatic ecosystem is an indicator of the presence of minerals. • The difference between longitudinal and cross-sectional studies.	background research and experimental evidence (including graphs). • Critique the validity of conclusions put forth by peers.

Stage 2 – Evidence

CODE (M or T)	**Evaluative Criteria** (for rubric)	
T, M	Performance Task • Conclusions are supported by evidence. • Visuals/graphs are used effectively to show display data and show connections. • Conclusion is related to health of the ecosystem. • Effective presentation skills (spoken and visual)	Performance Task *Students will demonstrate meaning-making and transfer by…* • **Klong Health Analysis:** Students will analyze the class data set, draw a conclusion and explain/defend them with quantitative evidence and graphs in front of their peers. Students may use any electronic form of presentation (prezi, powerpoint, google presentation), but may not make videos. Students will assess their peers presentations for: validity of conclusions and presentation skills
	Other Evidence • Careful and responsible handling of equipment	Other Evidence (e.g., formative) • **Tech Licenses:** Students will complete lab assignment where they use the lab sensors in a controlled, indoor environment (test liquids in beakers and view water samples with microscopes). I will issue "tech licenses" upon correct demonstration of equipment use. Once the tech licenses are issued, students will have permission to take equipment into the field.
M	• Correct application of	• **Longitudinal vs. Cross-sectional Studies:** Students will design (not perform) a longitudinal and a cross sectional study, including the

	each type of study	reason why each one works best as that type of study.
M	• Factual accuracy. • Ecological connections. • Relation to human impacts.	• **What do these values mean? A look at the significance of what we're measuring:** Students will complete and keep guided notes—describing the significance (healthy ranges, ecological connections, how they relate to human impact) of each quantity that is to be monitored. This will be completed in jigsaw format. These are to be kept and used as resources by students.
	• Timeliness • Accuracy. • Care	• Instructor will monitor completion of data table each week to make sure students are keeping up. Additionally, Instructor will monitor correct and thoughtful use of sensors and microscopes. (To be factored into students overall class participation grade.)
M,T	• Connections are made between variables. • Clear effort has been made to draw out *as many connections as possible.*	• **Mid-Semester Pre-Analysis:** Students will be issued paper copies of the data set. In groups they will brainstorm ideas and look for trends within the data. (Goal: students will begin "making sense" of the data and developing a focus—they may want to gather additional data relating to their focus).
M,T	• Connections are made between variables and supported by evidence. • Effort/cooperation • Completion	• **Rough Presentation Plan:** Students groups will create a "rough plan" of their presentation idea and receive/give peer feedback on it. Students must reference the class data and background research. Instructor will also collect and give written formative feedback.

Stage 3 – Learning Plan

CODE (A, M, T)	Pre-Assessment *How will you check students' prior knowledge, skill levels, and potential misconceptions?* Due to the exceptional nature of this UbD the pre-assessment is not the first step to occur. Because students need to begin taking data right away and because they don't necessarily need to understand the full significance of the data right when they begin collection, the pre-assessment occurs in step 3. *See Stage 3, Step 3	
	Learning Activities	Progress Monitoring (See Stage 2 for in-depth descriptions.)
A	**Step 1: Learning the Equipment (LESSON: 80 minute block)** Handout: "Tech License: Lab Guide" Students will complete indoor Tech Lab. Each student must successfully, open, use, and re-pack each apparatus. They will demonstrate this skill for the Vernier sensors and the microscopes. For the microscopes they will be required to demonstrate how to mount a wet slide and correctly focus at several different magnifications. They will also be required to correctly clean and dry slides. After successful demonstration of each skill, they will receive the instructor's signature. When they have gotten signatures on every skill they will receive a "tech license" which gives them permission to take the equipment out into the field. (Prior to this class students will complete a flipped classroom handout—watching demos of the equipment by pros on the Vernier website and completing a worksheet).	ASSN: "Tech License" ASSN: "Flipped lesson: learning the equipment"

A,M	**Step 2: The Benefits of a Longitudinal Study (LESSON: 40 minute period)** Handout: "Longitudinal vs. Cross-sectional studies" Instructor will direct teach the difference between a longitudinal and a cross-sectional study, giving specific examples of each. In groups students will brainstorm the pros and cons of each and will sketch designs for each one (not to be performed). Once completed, each group will share their ideas with the rest of the class.	ASSN: "Longitudinal vs. Cross-sectional studies."
M	**Step 3: Hook/Informal Pre-Assessment (LESSON: Steps 3, 4, and 5 to be taught in one 80 minute block)** Hook/preassesment: Stand at the front of the room with two different jars of water. Each jar is filled with water from each separate collection site (sites that will be used later for the study). Tell students where each sample was collected (use google earth). Ask students if the water is the same or different (tell them to think about the answer silently first). Split the class in half and put each half on one side of the room. Assign one side to brainstorm a list of what they think will be the *same* in both jars and to speculate on reasons why. Assign the other side to speculate on the *differences*. As students brainstorm, give hints about the surroundings of each site. Students will share their ideas and students will be allowed to contribute anything they think may have been missed by either side.	
A	***Step 4: Project Introduction*** *Handout: "Klong Longitudinal Study*: Project Description" ***EQ: What changes occur in an ecosystem over a long period of time?*** ***EQ: How do humans impact an ecosystem?*** ***EQ: How can we determine if an ecosystem is "healthy?"*** ***EQ: What are farming alternatives that can prevent the negative effects of water runoff and fertilization?*** ***EQ: What factors determine which taxa of organisms will live in a particular environment?*** Pass out klong longitudinal study project description. Read through with students and explain expectations. Emphasize the communal aspect of the study and the importance of serious participation from each class member. Show students where they will be recording data in the google spreadsheet and the physical book where they will catalogue the organisms living at each site. Students will catalogue the organisms and microorganisms in a physical book, where they can draw and number each organism. There will be a single class copy of this book that is kept in the classroom. There will be separate catalogues for each experimental site. Each time a new organism that is found it will be added to the catalogue and a careful drawing will be made—they will also attempt to identify the type of organism.	
T	**Step 5: Site Selection** As a class we will go down to the Klong sites and record the exact sites that students will monitor. The students will be held accountable for describing the physical boundaries of the site in detail. (If possible, strings on stakes, or PVC pipes will be used to create physical boundaries). Note that both sites should contain an ecosystem that is part terrestrial and part aquatic (part on the shore and part in the water). Descriptions of each site and the borders should be given in the class google doc, right next to the data sets. *Note Steps 2, 3, and 4 are intended to be completed in one 80-minute block.	Walk with students, ensure that sites meet requirements and borders are solidly constructed.

T	**Step 6: Data Collection (Continuous/All Year, data is to be collected weekly)** This will take place over the course of the entire year or semester (up to teacher discretion depending on time constraints, data clarity, and student interest). Students will collect data once a week from both sites at a particular time of day. Additionally, students will-recheck the water (using microscopes for new microorganisms) and decide if any new organisms need to be added to the catalogue. There will be separate data sets created for both klong sites. Ideally students will be assigned partners. Each pair will be assigned to test a different quantity and to input their data into the spreadsheet. They will be required to take data once a week. The student assignments will rotate every three or four weeks so each pair has an opportunity to perform more than one test. These are the tests that students will perform (note that I've also shown what each of these tests can indicate in an attempt to condense information): • Monitor nitrates: Indicator of fertilizer and production of nitrogen producing bacteria (Additionally applies nitrogen cycle, fertilizer constituents) • Monitor Calcium concentration: Indicator of minerals in the water (Rock deposits, soil characteristics) • Monitor pH levels: pH is also an indicator of harmful chemicals coming from farm runoff (or dumping) students monitor healthy threshold for animals. (Note that rainfall can lower pH) • Monitor water temperature: dissolved oxygen content is inversely related to temperature, so it makes sense to check the oxygen content at the same time as the temperature. • Monitor dissolved oxygen: indicator of turbulence and excess of organic plant matter. (Pollution causes a decrease in DO oxygen content--decomposition) • Monitor the outdoor temperature: factor for allowing students to make connections and comparisons of their other data • Monitor the time of day and date: Students can connect day times to temperature, seasonal changes and other factors • Monitor barometric pressure: Check to see if there is a connection of climactic factors. • Test the soil moisture (Can be connected to DO, rainfall, and humidity) • Catalog organisms (including microorganisms living in the ecosystem) *Note: It is important to try to make sure that each week students always take measurements at the same time of day. In other words: time of day is a controlled variable. (I imagine that we will do this every Monday during our shortened periods).	Monitor google doc for completion and accuracy of data (look for any outlying values as indicator of poor data collection).
A	**Step 7: What are we testing? (80 minute block)** Handouts: "What do these values mean? A look at the significance of what we're measuring." Assign student groups to research the significance of all quantity that they are testing (see step 6 for the list). Students will complete a jigsaw: "What do these values mean? A look at the significance of what we're measuring." Format: students will be put in small groups (3-4) and each student will be responsible for researching approximately three different quantities (to be done AT HOME. This will be assigned before the lesson.) Then they will return to their groups and teach their peers. When groups are finished sharing, we will go over each one as a class and the instructor will add in any missing	ASSN: "What do these values mean? A look at the significance of what we're measuring."

	information. Students will complete guided note sheets to organize and store this information. *Note Step 6 is to be completed sometime near the beginning of the semester; this will likely be 1-2 weeks after they begin collecting data.	
M	**Step 8: Mid-Semester Pre-Analysis: (LESSON 80 minute block)** Handouts: "Mid-Semester Pre-Analysis" and printed out data set The purpose of the pre-analysis is to encourage students to start looking for patterns and to remind them that the data they're collecting is meaningful. Students are assigned groups. Students are given the data set and asked to look through all the information and draw out as many patterns as they possibly can. Students are also encouraged to look for data that could be a sign of human impact. Students should be encouraged to use their "What do these values mean?" notes as a resource. They are asked to brainstorm a list of connections and to share their most interesting one with the rest of the class. *Note Step 8 is to be completed approximately halfway through the semester (or sooner if students begin to forget the purpose of their data collection). This lesson can be completed multiple times, depending on fluctuations in the data.	ASSN: "Mid-Semester Pre-Analysis."
A,M,T	**Step 9: Performance Task: (To be completed over several days)** Handouts: "Klong Health Analysis Rubric," "Klong Health Analysis: Assignment Sheet," and "Rough Presentation Plan" In groups of three, students will analyze the class data set and find a pattern or trend. Using class data, they will analyze the trend and use quantitative evidence to support a conclusion. It will be required that their conclusion relates to "health" of the klong environment. They will be required to support their conclusion using the class's experimental data set AND background research that relates to their particular topic. This means that students will need to conduct background research that is specific to their topic. Peers will use the assignment rubric to evaluate the validity of each group's conclusions and the quality of their presentation. As an intermediate step (i.e. before they begin work on their official presentations), students will be given a handout where they sketch out their idea. They will be asked to: 1) Identify the pattern/trend that they want to analyze. 2) Articulate the conclusion that they want to draw from it. 3) Explain how their conclusion is supported by evidence. 4) Explain how their conclusion relates to the health of the environment. *Note: During peer evaluations there will be a strong focus on the question: "Is this group's conclusion supported by evidence?" Students grades will be based on a combination of teacher assessment (75%) and peer assessment (25%)	ASSN: "Rough Presentation Plan" "Klong Health Analysis Rubric"

*ASSN Stands for "assignment."

*EQ stands for "essential question."

Klong Health Analysis: Assignment Sheet

Description: Using our class data set, your group is responsible for finding a trend or pattern among our measured variables and establishing a conclusion based on the data. You must also relate your conclusion to the "health" of the ecosystem. Your group will create a presentation (powerpoint, prezi, google presentation, or something else) to explain what you've found.

Expectations:

- Collaborate effectively with group members.
- Support conclusion with experimental evidence AND background research. (This means that you will have to do some additional research on your own. You also need to cite your sources!)
- Provide background information on the significance of the variables you analyzed. (How do they relate to the ecology and health of the ecosystem?)
- Relate your conclusion to the health of the ecosystem.
- Use visuals and graphs to show connections between variables.
- Presentation must be between 5 and 10 minutes.

Tips for a successful presentation:

- Speak clearly and act professionally.
- Don't read off your presentation slides.
- Use notecards as a memory aid, but don't read directly from them.
- As you build your presentation refer back to the rubric and the expectations to make sure that you have everything that is required.
- Practice ahead of time.
- Be knowledgeable—work hard on your analysis and talk about what you know!

Grading: Your final grade will be a combination of a grade given by me and a grade given to you by your peers.

- Percentage of grade given by me: 75%
- Percentage of grade given by peers: 25%
- Grading Scale: A = 18-21, B = 15-18, C = 12-15, D = 9-12, F = 0-9

*See Rubric

Due Date: TBA

Note: You will be given some class time to complete the project, but will also be expected to work on this at home.

Klong Health Analysis Rubric: **Presenters:** _____

	1	2	3	Comments:
Introduction	There is no background information given about this experiment.	Some background information is given, but it is unclear why the group decided to do this project.	Basic information of the science surrounding the presenters' project is given before they explain their experiment. It is clear what inspired the group to choose this project.	
Ecosystem Health	The conclusion is not supported experimental evidence or background research.	The conclusion is clearly supported by experimental evidence and background research. It is unclear how the conclusion relates to the "health" of the ecosystem.	Clear connections are made between the presenter's conclusion and the "health" of the ecosystem and possible human impacts. If the environment is shown to be unhealthy, restorative suggestions are made. Conclusion is clearly supported by experimental evidence and background research.	
Spoken Language	The presenters are unprepared. There are pauses in the presentation. Not all presenters understand the experiment. Group members do not contribute equally.	Most presenters are well prepared and have a good understanding of the experiment. The group does not read from a script. Group members do not contribute equally.	Presenters speak clearly and act professionally. They respond to all questions thoroughly. All group members contribute equally. The group may use presentation notes, but does not read directly from the slides or from a script.	
Presentation Visuals	Slides are messy and include typos. There are no pictures, tables, or graphs used. Important parts of the experiment are not shown or are skipped over in the presentation.	Each slide is clear and makes sense. Pictures, graphs, and tables are used, but some are poorly made. Presenters should have used more visuals to improve understanding.	Pictures are used to help the audience understand the experiment. Tables (and in some cases graphs) are used to visualize data. The slideshow is organized and visually pleasing.	
Originality, Risk-Taking, and Effort.	The experiment did not seem original. Presenters spent little time and effort on the experiment.	The presenters' experiment was somewhat challenging. Presenters spent moderate effort and time on the experiment.	The presenters' experiment was challenging and new to them. The presenters spent lots of effort and time on the experiment.	
Data Supports Conclusion ***Note: This row counts 2x as much as the other rows.**	The conclusion is *not* supported by data.	Conclusions are supported by the data. Presenters *do not* suggest possible improvements for this experiment in the future. Possible errors are mentioned.	Conclusions are supported by the group's data. Presenters *explain* why their conclusions are based on their data. Conclusions suggest possible improvements for this experiment in the future. Possible errors are mentioned.	

Total Score: _____ / 21